KRAIN COPPER DEPOSIT

HIGHLAND VALLEY, B.C.

March 23, 1971

J.J. Hylands

800592

CANEX AERIAL EXPLORATION LTD.
DIVISION OF CANADIAN EXPLORATION LIMITED
700 BURRARD BUILDING VANCOUVER 5, B. C. CANADA

March 23, 1971

M E M O R A N D U M FILE: V-82

TO: E.A. Scholz

FROM: J.J. Hylands

RE: Krain Copper Deposit, Highland Valley, B.C.

INTRODUCTION

The Krain Copper deposit is located about five miles north of Bethlehem Copper, in the Highland Valley area of the Guichon Batholith. It is the only large uncommitted deposit presently known in this area. In 1965 Canex optioned the property from North Pacific Mines and drilled sixteen vertical diamond drill holes. The option was dropped in 1966. A total of fifty seven diamond drill holes have been drilled in the area of the main showing since 1956.

The present study was undertaken to determine if guides to further exploration of this deposit could be developed. Previous work had indicated that:

1) there was approximately 30 x 10^6 tons of open-pittable ore grade oxide and sulphide mineralization;

2) the higher grade core had a partial pyritic halo;

3) the depth of the copper oxide capping increased towards the volcanic cover to the north and west;

4) interesting copper values were present at depths to 1,500 feet in a limited area; and

5) copper in the oxide material was leachable by sulphuric acid.

ORE RESERVES

Based on diamond drilling done up to 1966 E. Lonergan calculated reserves for an open pit with the pit bottom at 5,200 feet elevation, 400 feet below the surface.

1) Cut-off grade 0.30% Cu
   8.67 x 10^6 tons milling (sulphide) ore, 0.52% Cu
   13.0 x 10^6 tons oxide ore, 0.22% Cu

ORE RESERVES - continued

2) No cut-off grade

7.48×10^6 tons measured ore, 0.30% Cu
23.35×10^6 tons indicated ore, 0.20% Cu

Using the same data, C.E. Dunn calculated an inventory of 26.5×10^6 tons at 0.37% Cu, to the 4050 datum. The present review gives an inventory of

22.2×10^6 tons sulphide copper at 0.34% Cu,
13.4×10^6 tons oxide copper at 0.42% Cu
35.6×10^6 tons total at 0.37% Cu

"drill proven" to the 4,100 foot datum.

Extending the mineralized zone to 1,000 feet north of the baseline chosen for this compilation, and down to the 4,000 foot datum, gives 121×10^6 tons of sulphide copper at 0.30% Cu. In each calculation a tonnage factor of 12 cu.ft./ton was used.

COMPILATION

For this review a baseline was chosen to strike N45°E and pass through hole #1-65. Section lines were drawn perpendicular to this line, their location chosen so as to have the most information on the fewest sections. This resulted in nine sections approximately 100 feet apart. All available diamond drill hole data was plotted on these sections.

Examination of the sections shows that the "ore" boundary corresponds closely with the chalcopyrite/pyrite contact. The latter was drawn as objectively as possible, using core logs and assays as guides. The oxide zone was defined by the presence of malachite and/or chrysocolla. The boundaries defined on the sections were transferred to serial plans 200 feet apart in elevation, and to sections drawn parallel to the baseline.

Tonnages were determined by assigning a volume of influence to each drill hole. At the southeast ends of sections the chalcopyrite/pyrite contact was used as the edge of the copper sulphide zone. At the northwest ends, the volume of influence was extended 200 feet beyond the last hole.

OBSERVATIONS

In plan the copper sulphide zone, as defined by the chalcopyrite/pyrite contact, is triangular with the known apex to the southeast. The zone is open to the northwest, beneath the volcanic cover. The northeastern and southern boundaries are near vertical, but the "nose" appears to have a steep plunge to the west or northwest.

The volcanic cover to the northwest, on strike with the axis of the exposed part of the deposit, appears to have a flat base, whereas to the north the base dips to the north. The maximum thickness of 330 feet was found in hole #S-33, the most northern hole, which barely entered the mineralized zone. Massive unmineralized andesites comprise the volcanic section.

OBSERVATIONS - continued

The oxide zone is thickest over the centre of the copper sulphide "pipe", and appears to increase in thickness and decrease in grade to the northwest. The southern edge of the zone has had the copper leached out, leaving predominantly iron oxides. Oxide mineralization is predominantly malachite and chrysocolla, with subordinate cuprite, native copper, chalcocite and chalcopyrite.

The copper sulphide zone has been tested to a depth of 500 feet from about 400 feet south of the baseline to 800 feet north. Holes deeper than 800 feet have been drilled only in the southeast nose of the zone, and most of these have copper sulphides grading better than 0.20% Cu to the bottom. Assays from the deepest hole, #2-65, indicate that 0.22% Cu is present 1,500 feet below the surface. Three relatively deep holes, #S-30, 31 and 32, were drilled in the northern part of the deposit in 1967, but 150 to 300 feet of core from the bottom of each hole, stored on the property, still have to be assayed.

GEOPHYSICAL SURVEYS

An induced polarization survey was conducted in 1969 by McPhar Geophysics Limited for Noranda Mines. Percent frequency effect (%FE) values have been contoured on the surface map included with this review. The highest %FE values coincide with the pyrite zone southeast of the deposit. Other highs (greater than 2.0% FE) are north, northwest and west of the deposit, overlying undrilled volcanics. Inasmuch as the volcanics are massive, unaltered and unmineralized andesites, it could be assumed that the granitic rocks underlying these highs have been strongly pyritized. The I.P. highs could also be caused by the nature of the weathered material lying between the volcanic and granitic rocks. If the former is the case, limits to the copper sulphide mineralization can be projected, and drill targets chosen. This I.P. survey was not carried beyond about 1,200 feet northwest of the baseline, so the western I.P. anomaly cannot be precisely defined.

A magnetometer survey was conducted by Beaverlodge Uranium Mines Ltd. The results, as contoured by Northwestern Explorations Ltd., show a north-south orientation of highs and lows, with the mineralized zone being relatively low. Diamond drilling of the low areas (1955-1957) indicated that they occurred at contacts between altered diorite and porphyry.

On the aeromagnetic map published by the British Columbia Department of Mines the Krain deposit lies on a magnetic "slope" which dips west to an area of low susceptibility beneath Forge Mountain. In general, the Kamloops volcanics are marked by large areas of low magnetic response when compared to adjoining areas of plutonic rock, although the andesites contain more magnetite. In particular, there is a marked magnetic low beneath Forge Peak (6,500 feet elevation) which is on strike with the axis of the deposit.

SUMMARY OF METALLURGICAL TESTS

1965 - Britton Research Laboratories
A composite sample from surface showings adits and drill sample rejects was used. It assayed 0.26% oxide copper, 0.24% sulphide copper. All material was ground to -100 mesh, and 50% was -200 mesh.

Three approaches were used:

1) Direct flotation - ineffective, copper oxides would not float. Gave 40% copper recovery, concentrate contained 30% copper.

2) Acid Leach (H_2SO_4) + filtration - acid consumption was high, about 200 lbs. acid/ton material. Copper recovery was 68%.

3) Acid Leach + precipitation + flotation - 75% of copper was recovered, and the concentrate contained 35% copper. Acid consumption was 100 lbs/ton; powdered iron precipitant consumption was 30-40 lbs/ton.

Heap leaching of oxide material crushed to -3" was recommended. This would require addition H_2SO_4 to start action, plus sulphur or pyritic material to sustain acid production. No heap leaching tests were run.

1970 - B.C. Research Council

First test - Nine samples were used - 3 of copper oxides, 3 of pyritic, and 3 of copper sulphide. All material was ground to -400 mesh before testing.

Two approaches were used:

1) Microbiological leaching - proved ineffective.

2) Acid leaching

oxide samples - less than 50% recovery at pH = 2.5
- up to 95% recovery at pH = 1.5, acid consumption 175 lbs/ton.

pyritic samples-produced H_2SO_4, less than 53% copper recovery.

copper sulphides
- acid leaching was ineffective, and no H_2SO_4 was produced.

Second test - 120 samples of percussion drill hole cuttings, all from oxide copper zone. All material tested was ground to -400 mesh with exception of four samples that were tested in original condition and then pulverized. Each sample was made into a slurry which was stirred during leaching. At pH = 2 the samples were leached for 6 hours; at pH = 1.5, 16 hours.

At pH = 2, copper recovery was less than 50% at pH = 1.5, copper recovery was fairly evenly distributed between 10% and 80%.

At both pH's % copper recovery is directly related to the amount of copper available, and to acid consumption, as would be expected.

Third test - Three samples had their clay particles elutriated in flowing water, and the residue leached with H_2SO_4. There was no improvement in copper recovery or reduction in acid consumption.

GENERAL

Petrographic examination of the cuttings showed negligible sulphides in the oxide zone. The oxides could not be activated for flotation by sulphidization. Specific gravity tests indicated that the green oxide mineral was predominantly chrysocolla. Comparative tests on selected samples showed that the oxide copper results obtained by standard analysis (hot H_2SO_4 digestion, Bethlehem Copper) were about one half those obtained by a multiple leaching technique used by the B.C. Research Council.

Four of the samples in test two were split, with one half of each being leached in "as received" condition (drill cuttings), and the other half being ground to -400 mesh and leached. In six of the eight tests the pulverized material required more acid to achieve approximately the same % copper recovery as obtained with the coarser samples.

CONCLUSIONS

Approximately 10 million tons of sulphide material, grading 0.50% Cu, and 13.5 million tons of oxide material, grading 0.42% Cu, are mineable in the Krain deposit by open pit methods. The drill proven sulphide inventory is approximately 22 million tons at 0.34% Cu, to a depth locally of 1,500 feet below the surface.

The mineralized zone is triangular in plan, with the extension to the north and west, covered by volcanics of unknown total thickness, undefined. A reasonable extrapolation to the deposit-volcanic contact, and to a depth of 1,500 feet, would give about 120 million tons grading around 0.30% Cu.

There is a strong correlation between percent frequency effect and pyrite concentration in this deposit. Using this correlation, an approximate northern boundary for the mineralization can be drawn. The I.P. survey did not extend far enough west over the volcanics to use this correlation to draw a western boundary. Results of the ground magnetometer survey are inconclusive.

The sulphide material is amenable to recovery by flotation, but the oxides are not. It is unknown at present if the copper in the oxide material can be recovered economically. Most of the oxide copper appears to be in chrysocolla; leaching with H_2SO_4 has given very poor recoveries, and high acid consumption, in laboratory tests. However, these tests were not realistic from the point of view of heap leaching because the samples were ground far too fine. It is also possible that the high acid consumption is directly related to the fineness of the material.

The tonnage indicated to a depth of 400 feet is insufficient to satisfy Placer's requirements for an open pit operation. Although a depth of 1,500 feet is indicated, the present grade is too low to support a block caving operation. The grade of the oxide copper material is probably closer to 0.80% Cu than 0.40% Cu, but extraction of this copper has proven difficult and expensive so far.

However, this deposit has not been fully explored. It is not expected that the grade can be markedly improved, but a tenfold increase in the tonnage grading 0.50% Cu is certainly possible. The thickness of the volcanic cover west and northwest of the deposit is unknown; it may be less than presently though.

RECOMMENDATIONS

It is therefore recommended that, if a satisfactory agreement can be reached with North Pacific Mines, the following steps be taken. Action on subsequent phases will be dependent upon obtaining satisfactory results from the previous ones.

Phase 1

a) obtain remainder of holes #S-30, 31 and 32 (marked in red on sections) and have the core split and assayed for sulphide copper, oxide copper and molybdenite.

b) deepen holes #19-65 (sec. 360 SW) and #S-31 (sec. 0) to a minimum depth of 1,500 feet each; deepen hole #S-33 (sec. 500 NE) to a minimum depth of 1,000 feet (holes marked in green on plans and sections).

c) extend the I.P. coverage to 2,000 feet northwest of the baseline.

Phase 2

a) drill two holes 1,500 feet deep, 600 feet northwest of the baseline - sections 160 SW and 200 NE (marked in blue on plans and sections).

b) drill three holes 1,500 feet deep, 600 feet northwest of the baseline - sections 270 SW, 300 NE and 600 NE (marked in orange on plans and sections).

c) initiate research on feasibility of heap leaching copper oxides available on Krain property.

Phase 3

a) drill two or more holes north of hole #S-33 (marked in purple on surface plan).

b) start fill-in drilling in main part of deposit.

COSTS

Phase 1

a) 72 samples @ $9.00 each	648.00
b) 2,600 feet of B.Q. core @ $15.00/ft.	29,000.00
c) 4 line miles of I.P. @ $400/mile	1,600.00
4 line miles of picket line @ $ $150/mile	600.00
Camp and supervision, one month	5,000.00
	$46,848.00

Phase 2		
a)	3,000 feet of B.Q. core @ $15.00/ft.	45,000.00
b)	4,500 feet of B.Q. core @ $15.00/ft.	67,500.00
c)	heap leaching tests start-up	10,000.00
	Camp and supervision, two months	10,000.00
		$132,500.00
Phase 3		
a)	2,000 feet of B.Q. core @ $15.00/ft.	30,000.00
	Camp and supervision, one month	5,000.00
		$35,000.00
	Total without fill-in drilling	$214,348.00

Krain Copper Oxide Reserves

Section	Tons x10^6	Grade % Cu	
450 SW	1.04	.06	= iron oxides + pyrite
360 SW	1.35	.03	
	2.39	.043	
270 SW	1.31	.25	
160 SW	2.19	.37	
0	3.90	.59	
100 NE	1.41	.60	
200 NE	1.14	.69	= chrysocolla + malachite
300 NE	.73	.25	
600 NE	.38	.59	
	11.06	.495	

Krain Sulphide Inventory, Drill Proven

Section	Tons x10^6	Grade % Cu
450 SW	1.23	.310
360 SW	.63	.012
270 SW	2.70	.391
160 SW	5.88	.297
0	3.97	.453
100 NE	4.20	.378
200 NE	.67	.180
300 NE	1.24	.190
600 NE	.71	.240
	22.23	.335

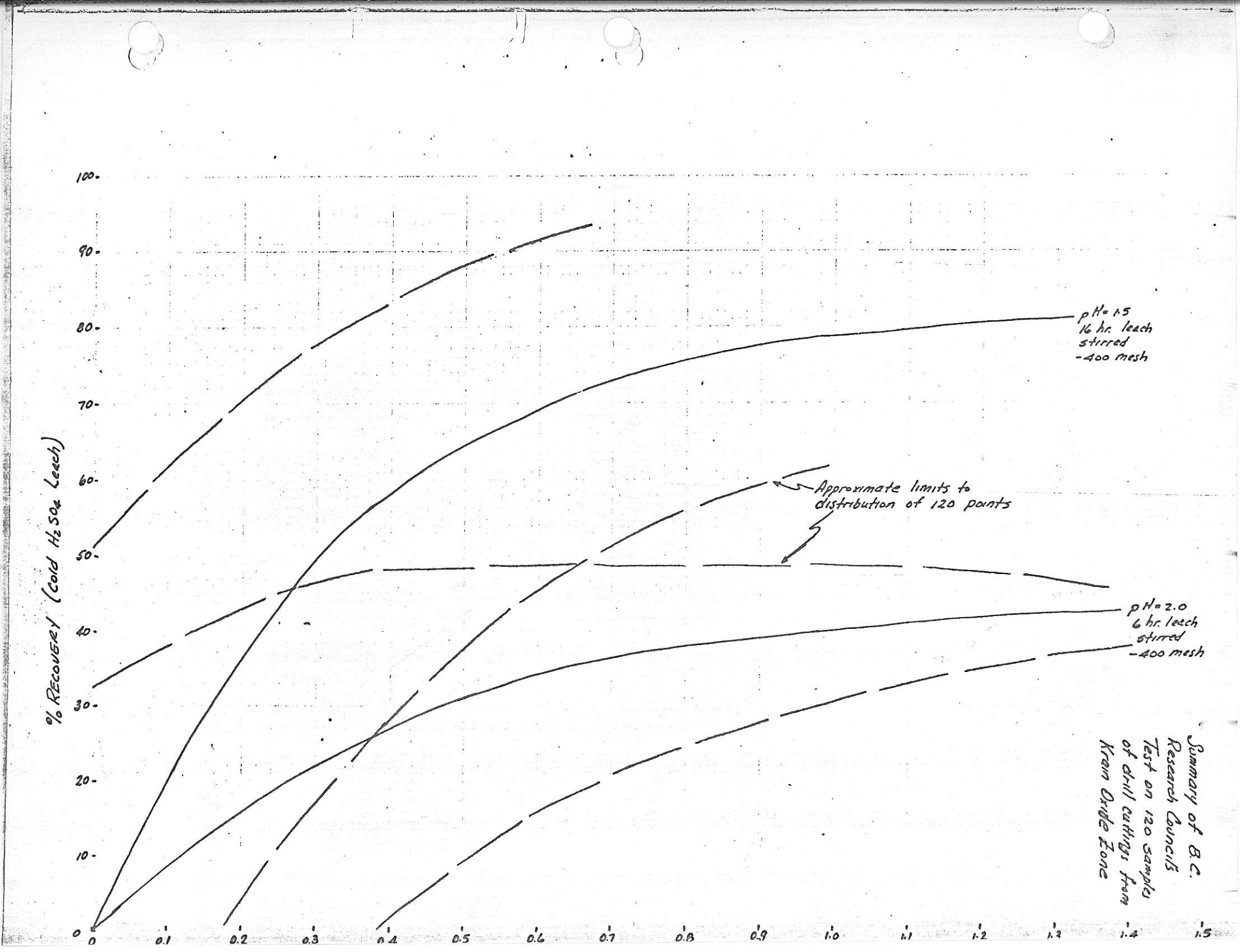
Extrapolation of Krain Sulphide Zone to 1,000 feet northwest of baseline and 4,000 foot datum

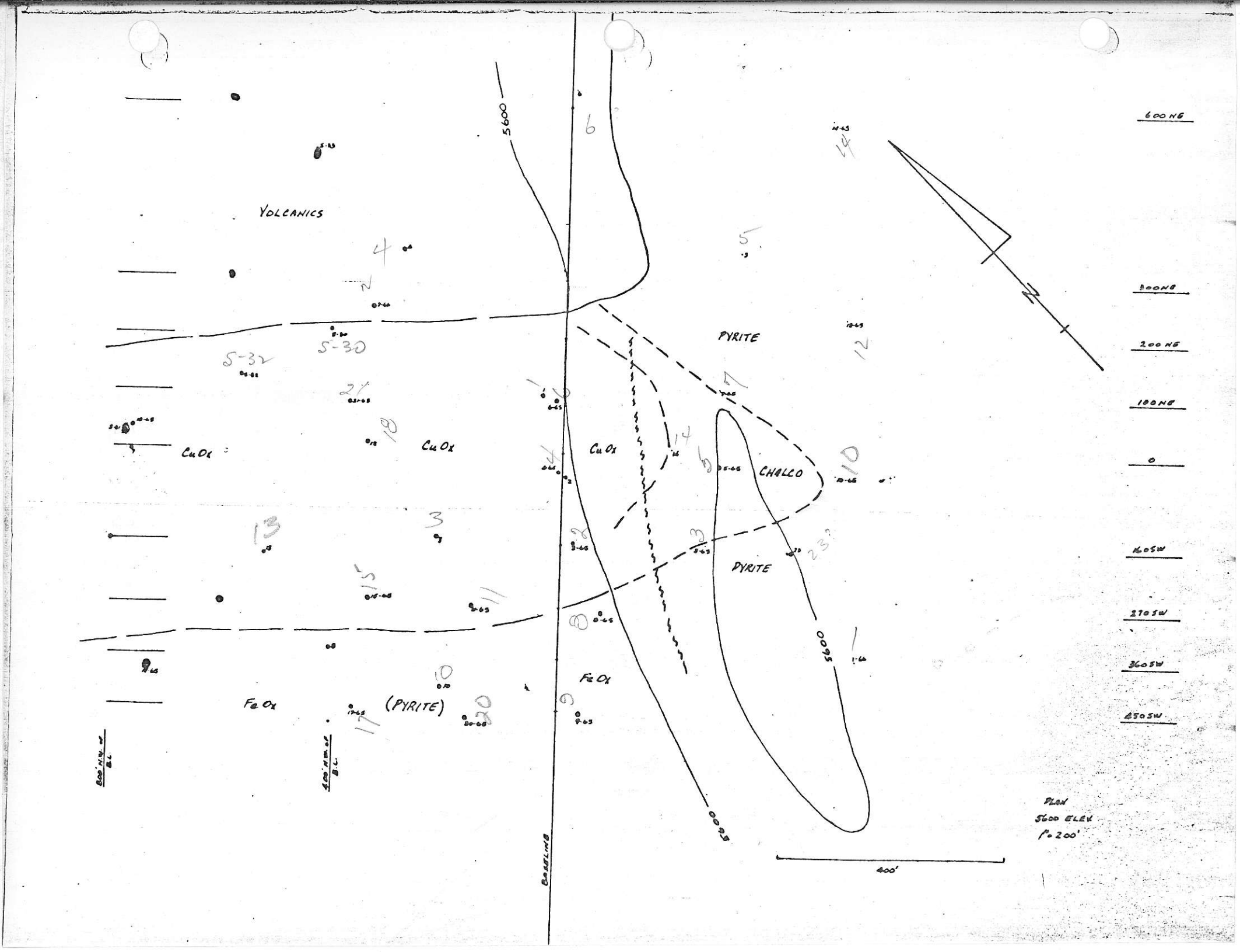
Section	Tons	Grade
	$x10^6$	% Cu
450 SW	12.15	.310
360 SW	9.75	.012
270 SW	14.45	.391
160 SW	21.90	.297
0	19.35	.453
100 NE	12.10	.378
200 NE	7.50	.180
300 NE	12.13	.190
600 NE	11.43	.240
	120.76	.296

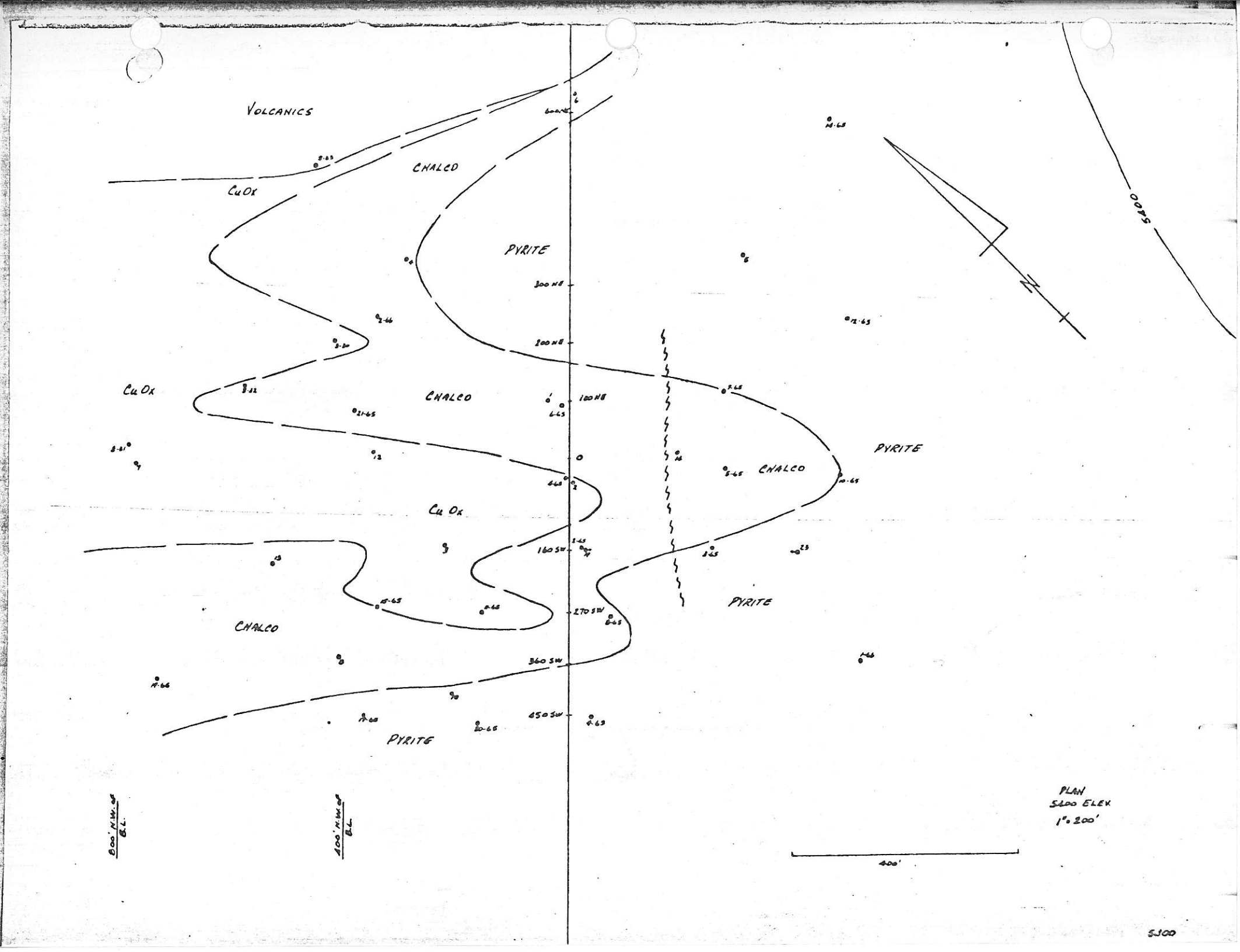
Vancouver, B.C.
March 23, 1971

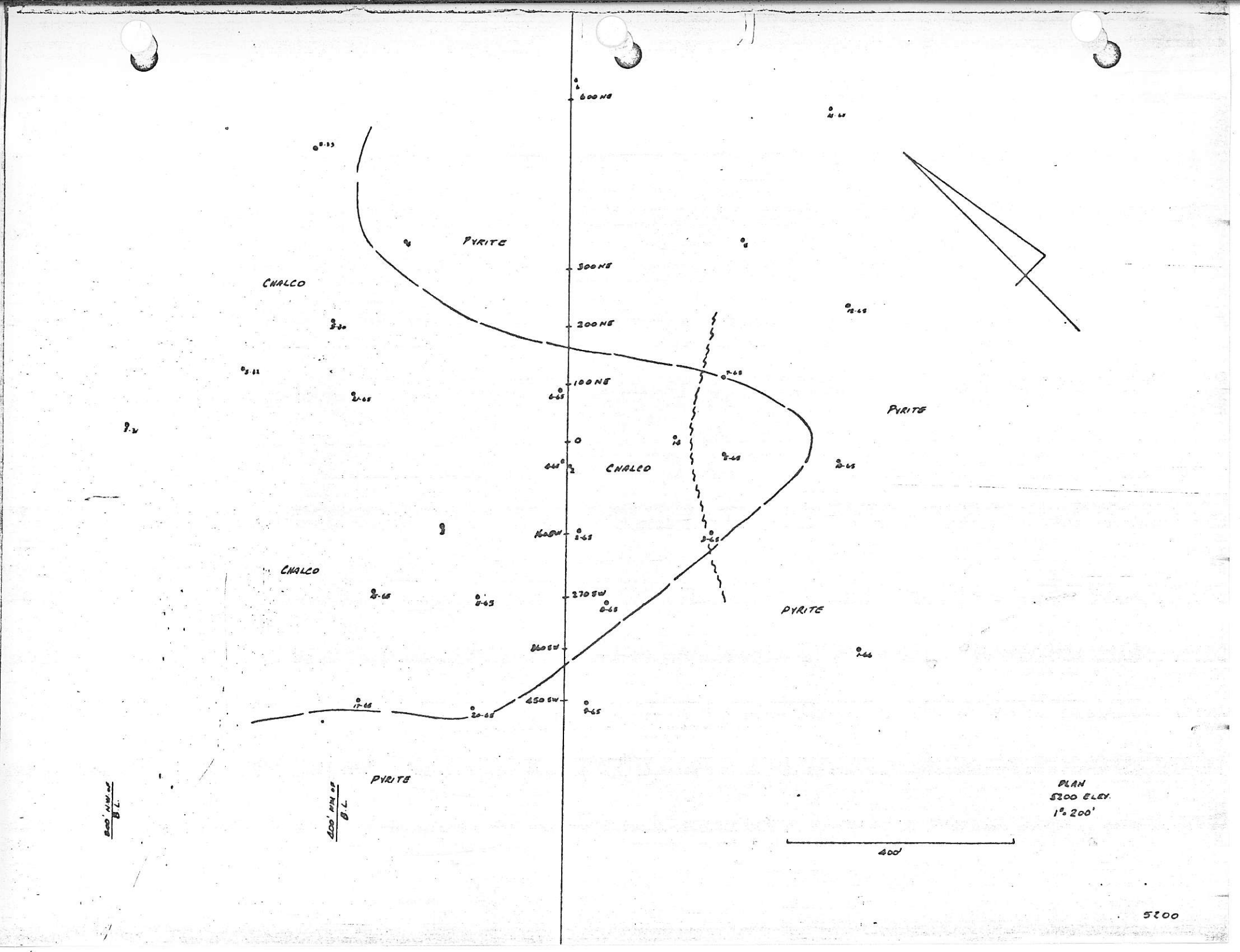
JJH/mz

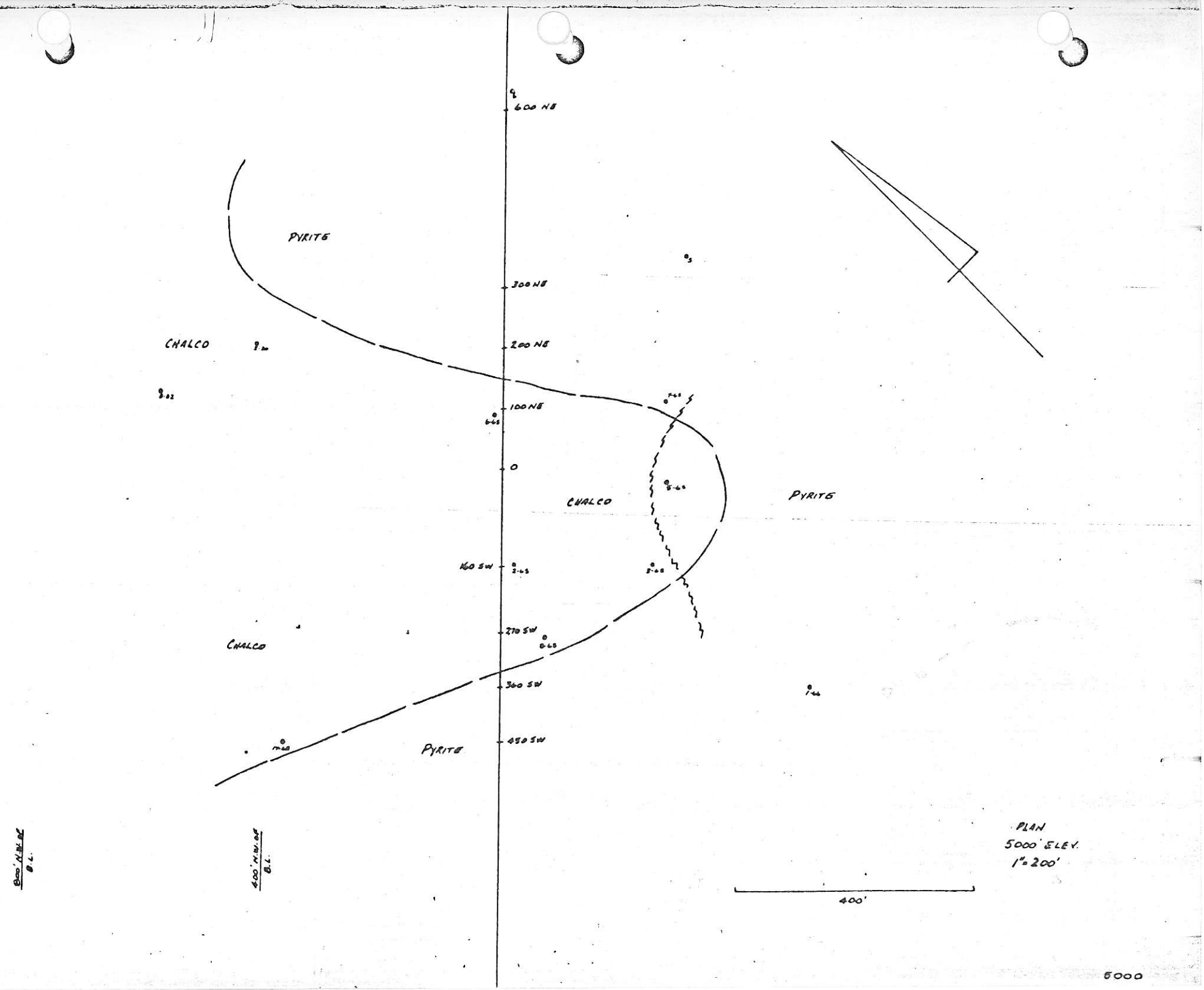
J.J. Hylands

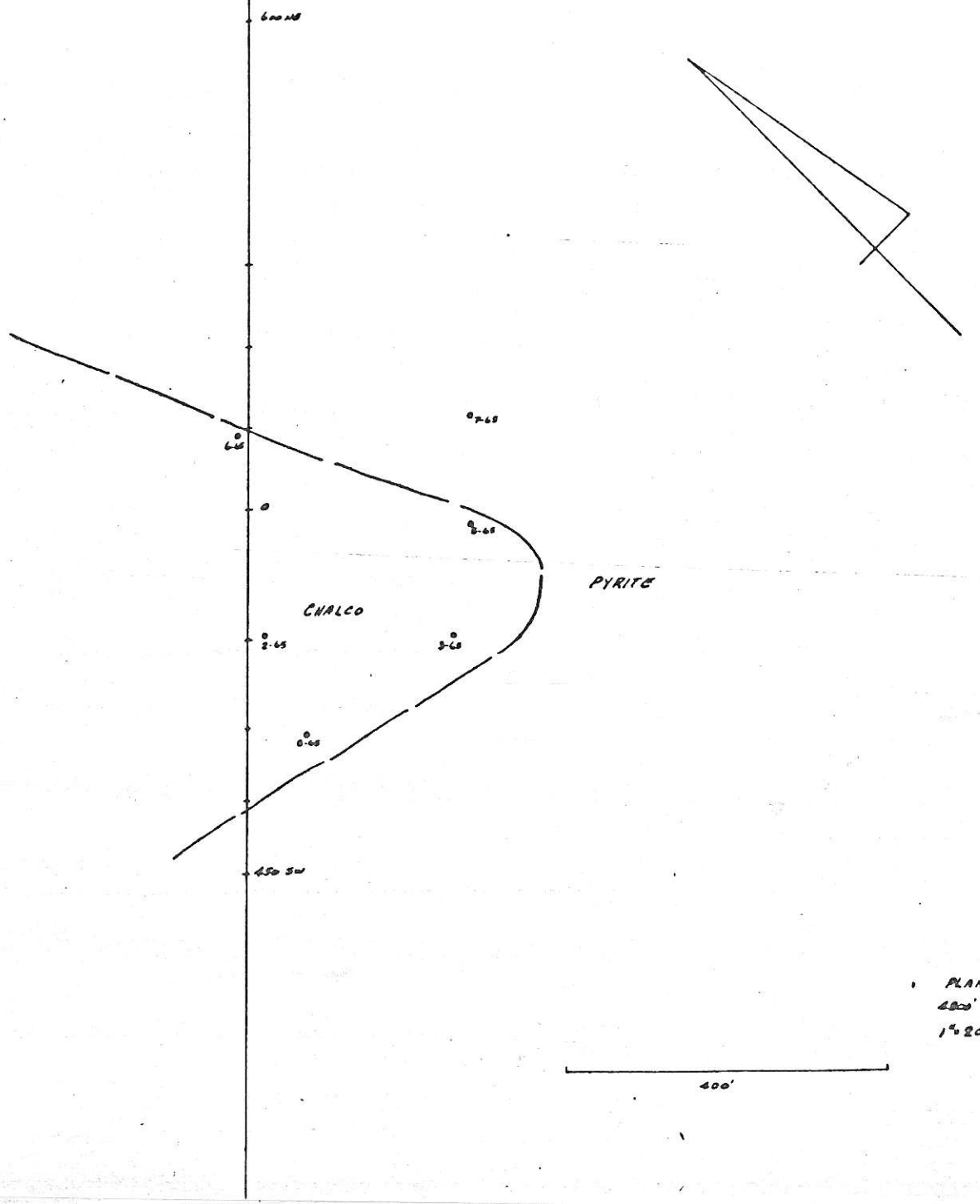

% Recovery (Cold H_2SO_4 Leach)
100
90
80
70
60
50
40
30
20
10
0
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
1.1
1.2
1.3
1.4
1.5
pH=1.5
16 hr. leach
stirred
-400 mesh
Approximate limits to
distribution of 120 points
pH=2.0
6 hr. leach
stirred
-400 mesh
Summary of B.C.
Research Councils
Test on 120 samples
of drill cuttings from
Kram Oxide Zone


VOLCANICS
5600
Cu Ox
Cu Ox
Cu Ox
Fe Ox
(PYRITE)
Fe Ox
PYRITE
CHALCO
PYRITE
5600
5600
BASELINE
600 N
300 N
200 N
100 N
0
K05W
270SW
360SW
450SW
PLAN
5600 ELEV
1"=200'
400'


VOLCANICS
CHALCO
CuOx
PYRITE
CuOx
CHALCO
PYRITE
CHALCO
CuOx
CHALCO
PYRITE
PYRITE
600' N.W. of B.L.
400' N.W. of B.L.
100 NE
200 NE
300 NE
160 SW
270 SW
360 SW
450 SW
S.100
PLAN
S.100 ELEV
1" = 200'
400'

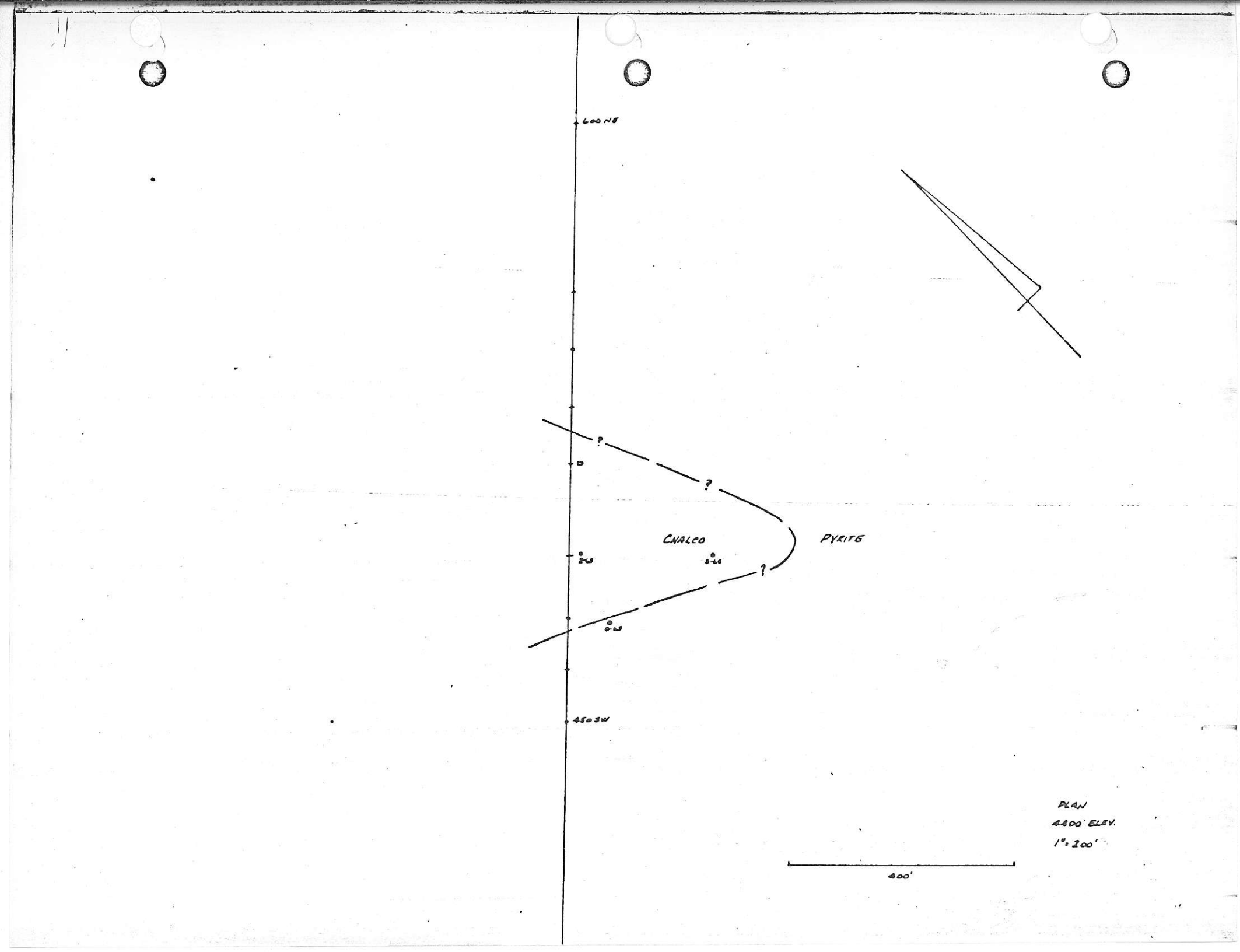

600 NE
500 NE
200 NE
100 NE
0
100 SW
270 SW
400 SW
450 SW
PYRITE
CHALCO
PYRITE
CHALCO
CHALCO
PYRITE
PYRITE
PLAN
5200 ELEV.
1" = 200'
400'
5200

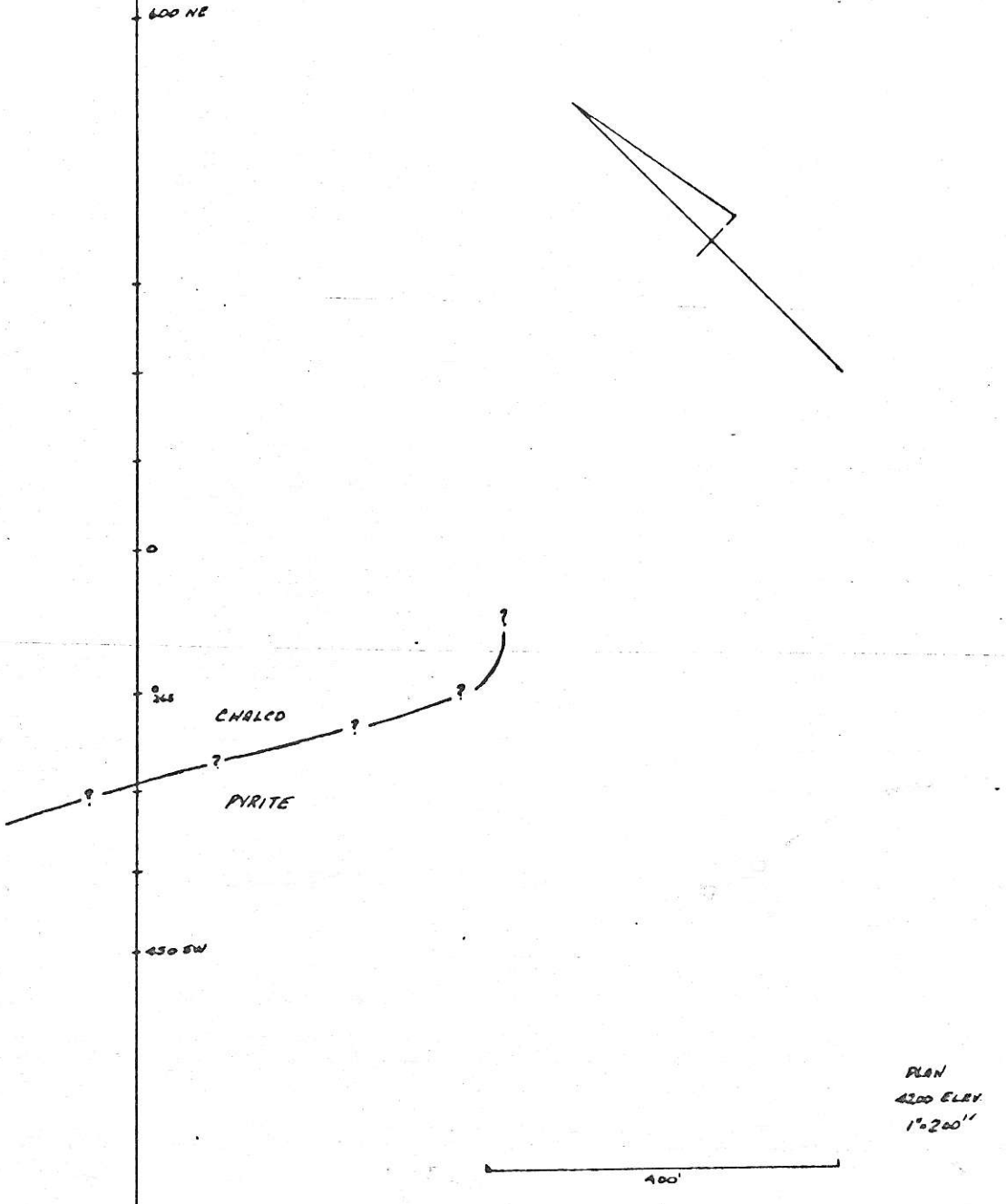

600 NE
300 NE
200 NE
100 NE
0
100 SW
270 SW
360 SW
450 SW
PYRITE
CHALCO
CHALCO
CHALCO
PYRITE
PYRITE
PLAN
5000' ELEV.
1"=200'
400'
5000



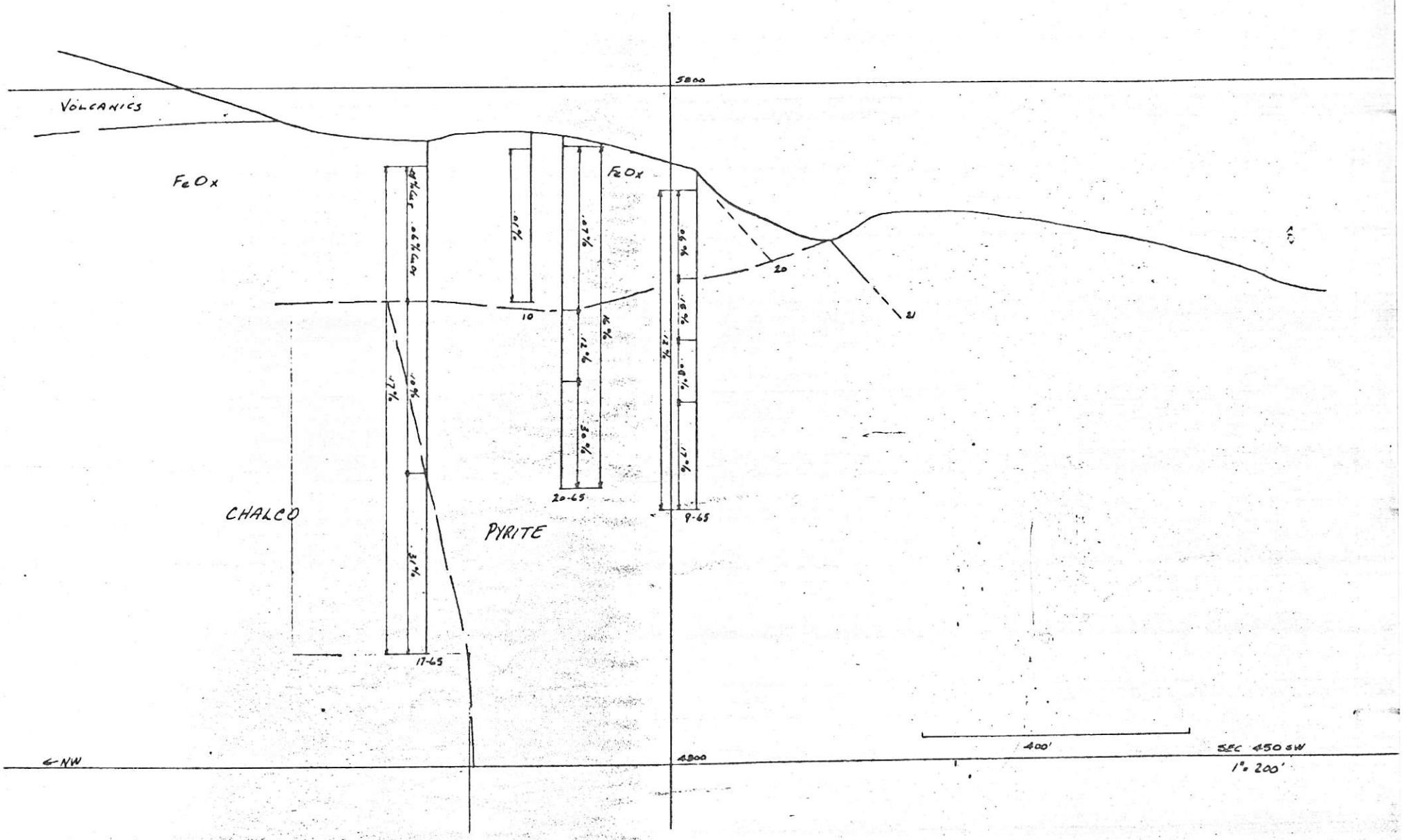
PLAN
4800' ELEV.
1" = 200'

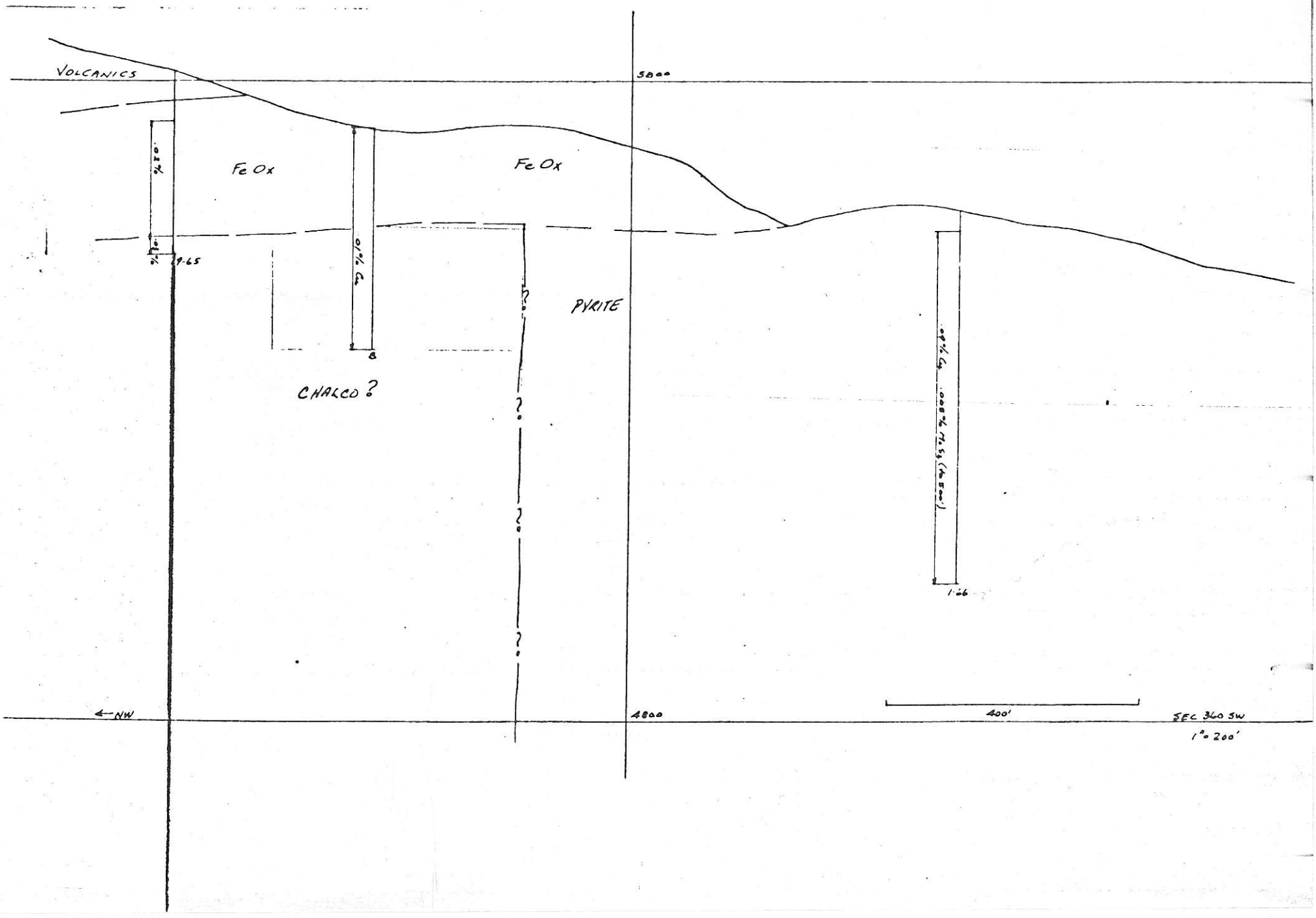
4800


600 NE
?
0
?
CHALCO
PYRITE
?
450 SW
PLAN
4800' ELEV.
1" = 200'
400'



4200


5800
VOLCANICS
FeOx
FeOx
20
10
20-65
9-65
17-65
CHALCO
PYRITE
4800
← NW
400'
SEC 450 SW
1" = 200'


VOLCANICS
5000
Fe Ox
Fe Ox
9.65
PYRITE
CHALCO?
4800
400'
←NW
SEC 36 SW
1"=200'

VOLCANICS

Cu Ox

Cu Ox

PYRITE

PYRITE

CHALCO

5800

4800

8000

← NW

SEC 270 SW

400'

1"=200'

5200

VOLCANICS

Cu Ox

Cu Ox

CHALCO

CHALCO

PYRITE

CHALCO

CHALCO?

CHALCO

PYRITE

4800

4000

← NW

SEC 160 SW

400'

1" = 200'

5800

VOLCANICS

Cu Ox

Cu Ox

Cu Ox

CHALCO?

CHALCO

CHALCO

PYRITE

PYRITE

PYRITE

4800

4000

← NW

400'

SEC O
1" = 200'

5800

LAKE

VOLCANICS

Cu Ox

CHALCO

CHALCO

CHALCO?

PYRITE

PYRITE

21-65

7-65

6-65

5-32

4800

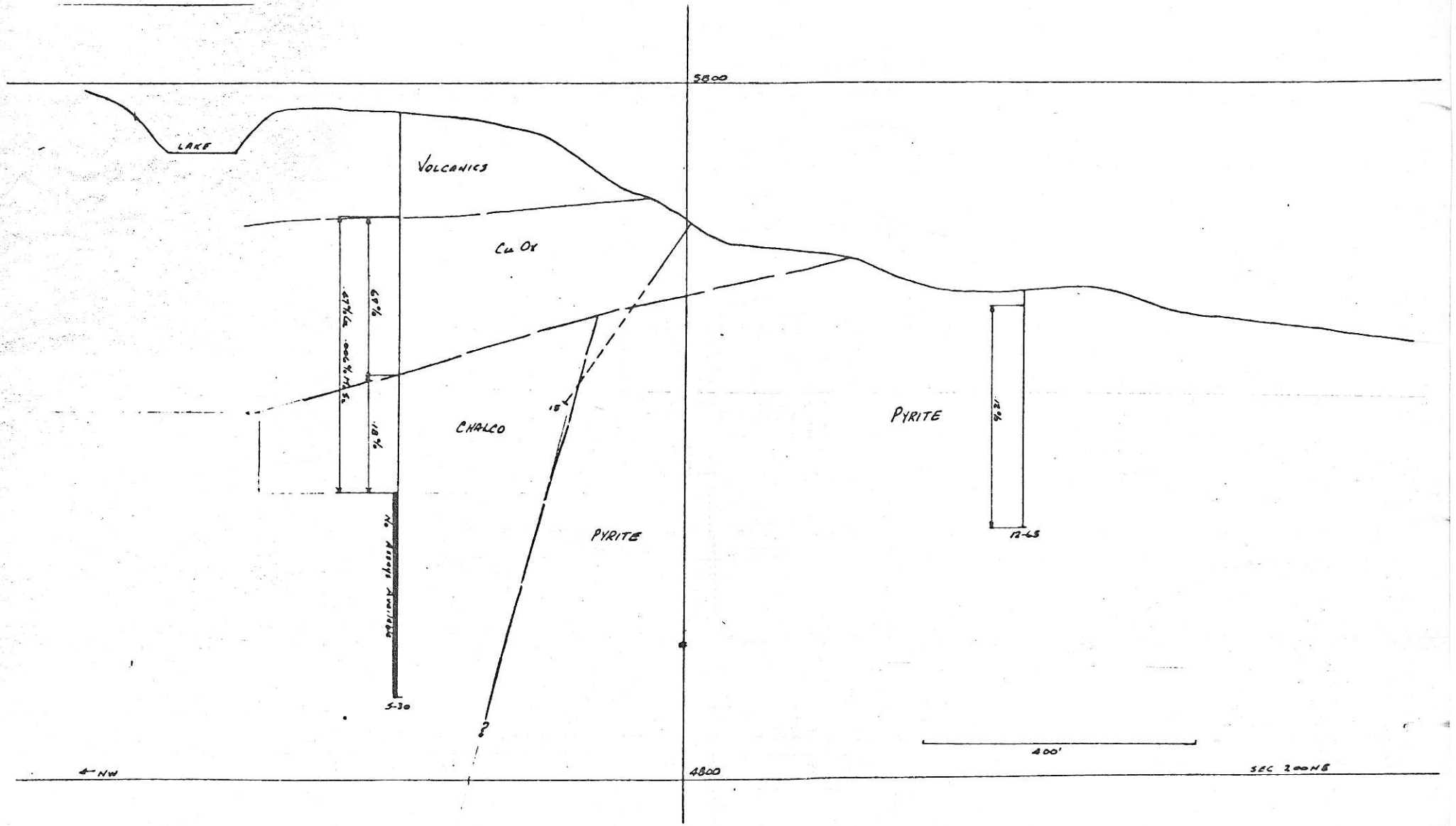
4000

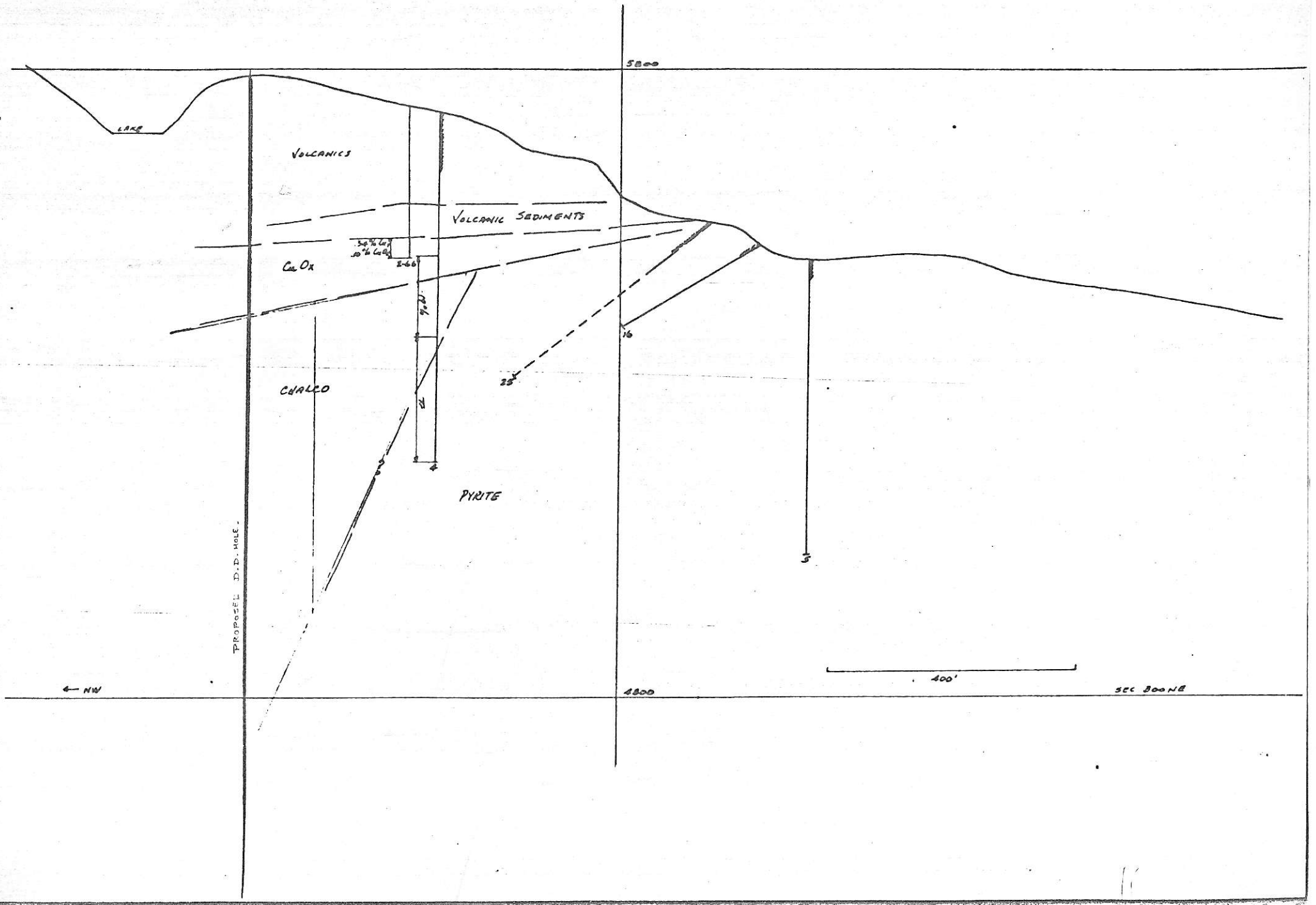
400'

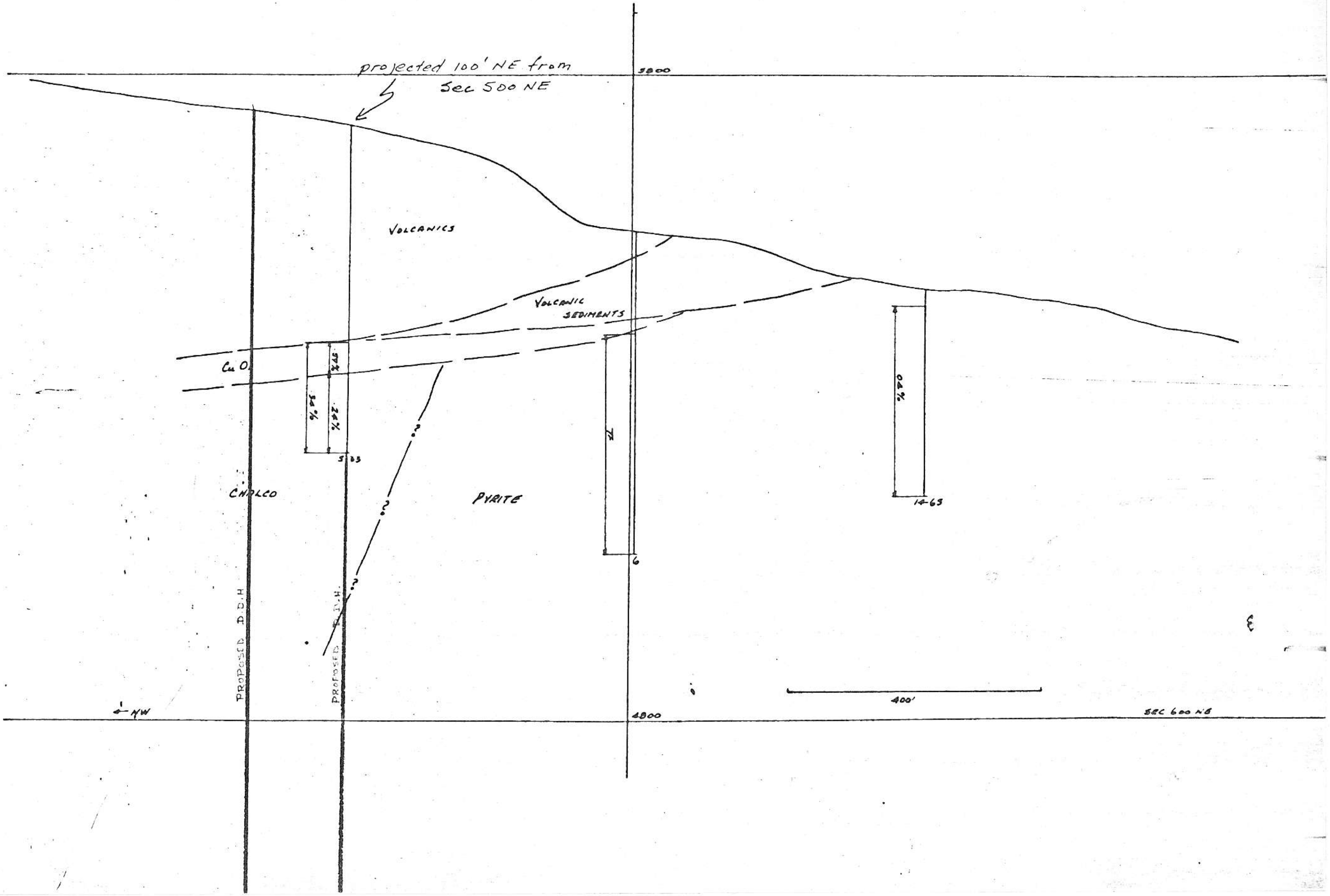
SEC. 100 NE

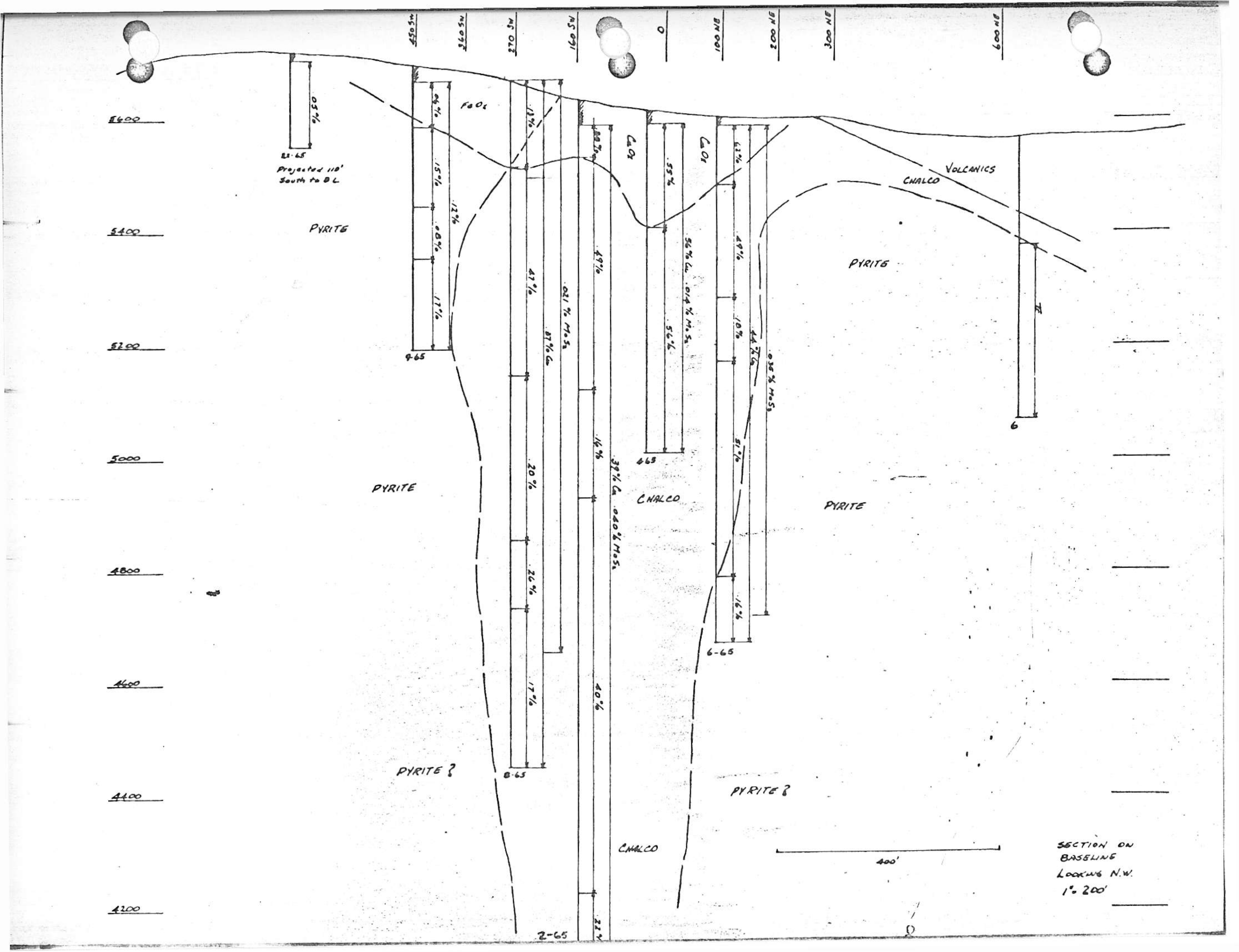
1" = 200'

← NW

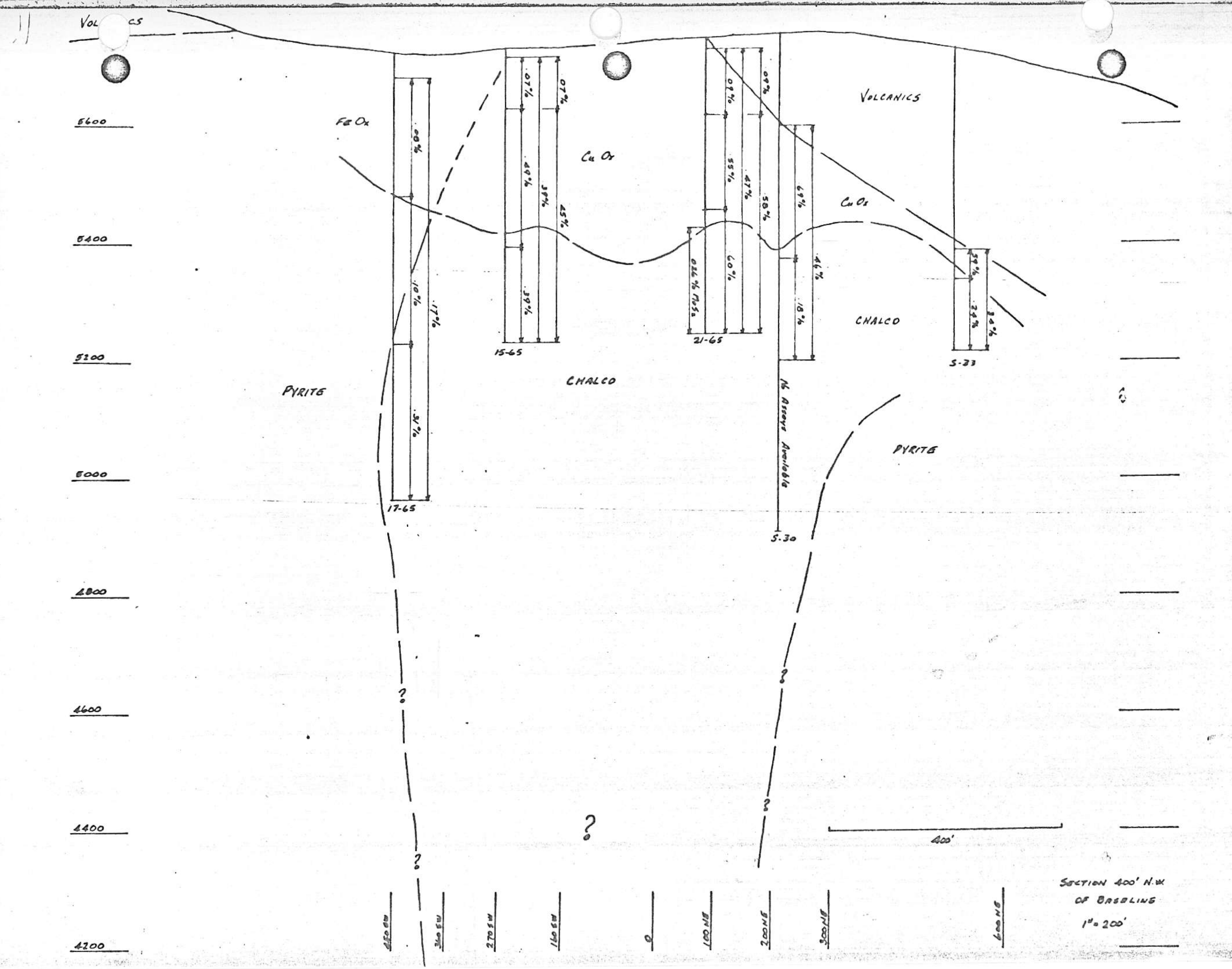

5800
LAKE
VOLCANICS
Cu Ox
.67%Cu .006%MoS2
.69%
.18%
CHALCO
18°
PYRITE
.12%
12-65
No. ARROW AMERICA
S-30
PYRITE
?
400'
4 NW
4800
SEC 20 N 8

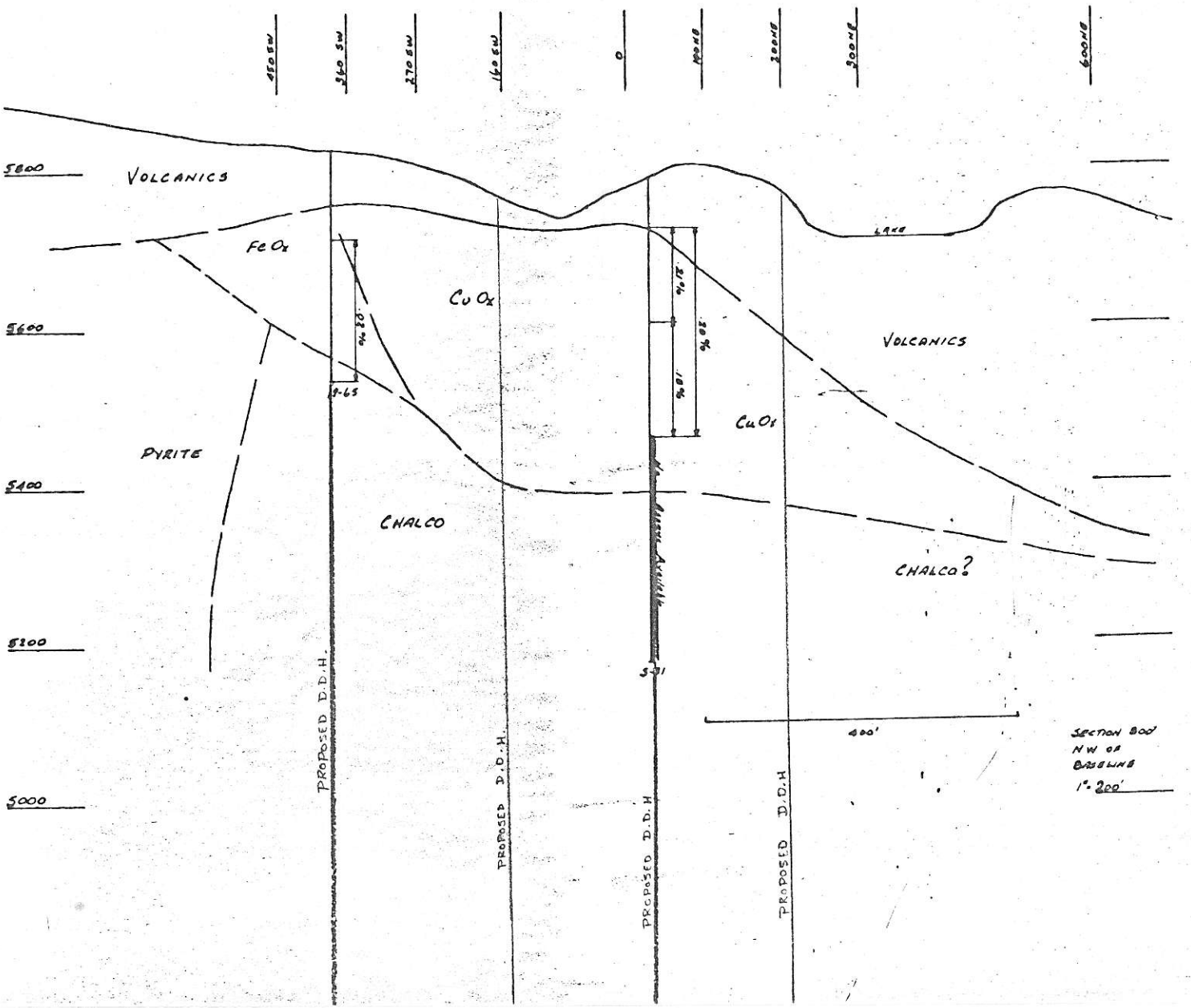

5800
LAKE
VOLCANICS
VOLCANIC SEDIMENTS
Cu Ox
CHALCO
PYRITE
PROPOSED D.D. HOLE.
16
25
5
400'
← NW
4800
SEC 800 NE

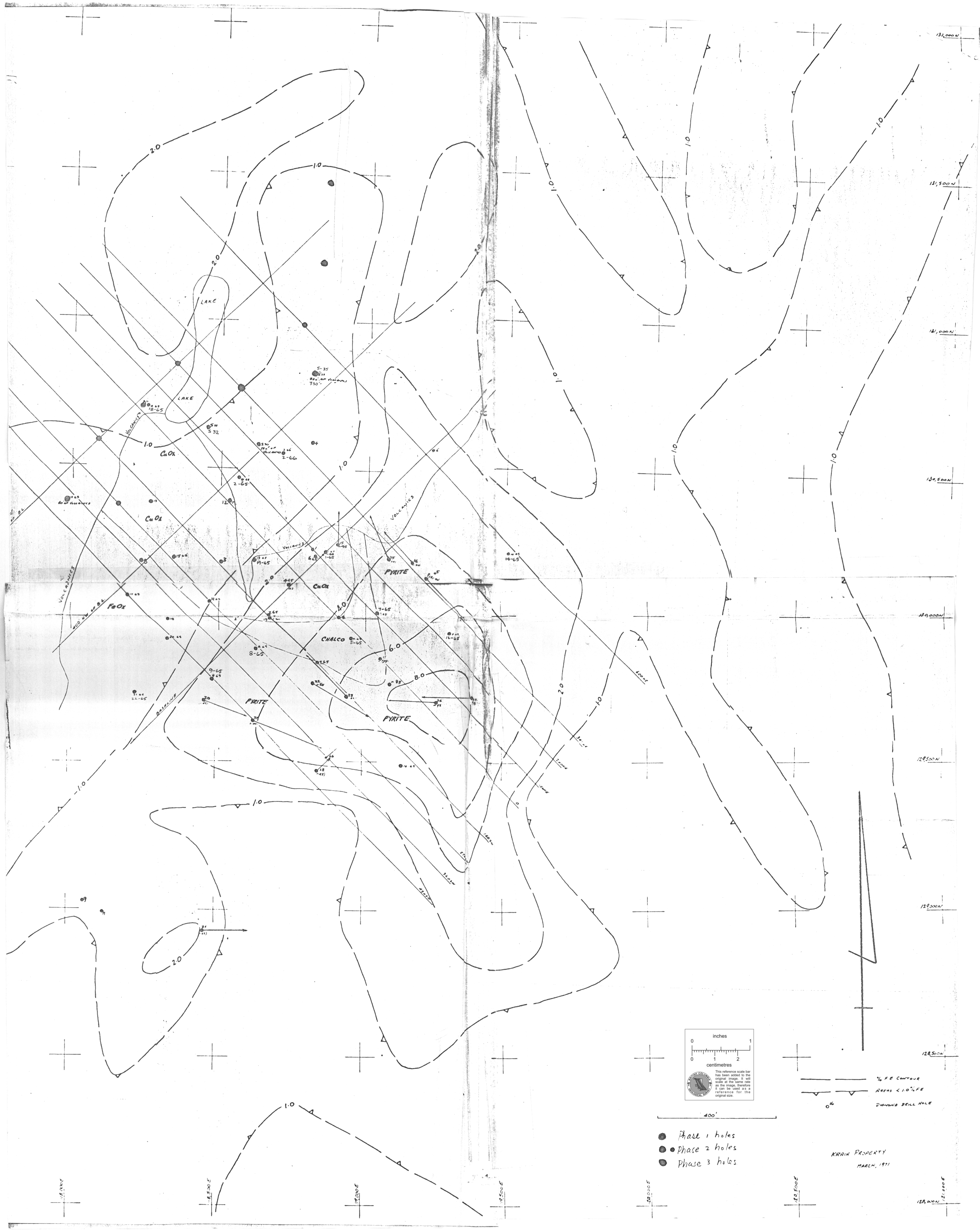

projected 100' NE from
Sec 500 NE
5800
VOLCANICS
VOLCANIC
SEDIMENTS
Cu O.
.24%
.04%
14-65
6
CHALCO
PYRITE
PROPOSED D.D.H.
PROPOSED D.D.H.
400'
NW
4800
SEC 600 NE



450 SW
360 SW
270 SW
160 SW
0
100 NE
200 NE
300 NE
600 NE
5600
5400
5200
5000
4800
4600
4400
4200
.05%
21-65
Projected 110' South to B.L.
PYRITE
FeOx
.12%
.15%
.08%
.17%
9-65
.13%
.47%
.021% MoS2
.87% Cu
.20%
.26%
.17%
8-65
CuOx
.55%
.56% Cu .014% MoS2
.56%
4-63
.49%
.16%
.39% Cu .040% MoS2
.40%
2-65
CHALCO
.49%
.10%
.15%
.16%
.035% MoS2
6-65
VOLCANICS
CHALCO
PYRITE
6
PYRITE
PYRITE ?
PYRITE ?
CHALCO
400'
SECTION ON BASELINE
LOOKING N.W.
1" = 200'


VOLCANICS
5600
5400
5200
5000
4800
4600
4400
4200
Fe Ox
Cu Ox
Cu Ox
CHALCO
CHALCO
PYRITE
PYRITE
17-65
15-65
21-65
5-30
5-33
No Assays Available
400'
360SW
270SW
160SW
0
100NE
200NE
300NE
600NE
SECTION 400' N.W.
OF BASELINE
1" = 200'


450 SW
360 SW
270 SW
160 SW
0
100 NE
200 NE
300 NE
600 NE
5800
5600
5400
5200
5000
VOLCANICS
Fe Ox
Cu Ox
PYRITE
CHALCO
LAKE
VOLCANICS
Cu Ox
CHALCO?
%.20
%.65
%.18
%.01
%.05
S-71
PROPOSED D.D.H.
PROPOSED D.D.H
PROPOSED D.D.H
PROPOSED D.D.H
400'
SECTION 800 NW OF BASELINE
1"=200'


LAKE
LAKE
VOLCANICS
VOLCANICS
VOLCANICS
CuOx
CuOx
CuOx
FeOx
CHALCO
PYRITE
PYRITE
PYRITE
BASELINE
400' NW of B.L.
18-65
S 32
2-66
2-65
5-35
330'
19-65
1-65
8-65
9-65
5-65
7-65
12-65
14-65
22-65
600NE
300NE
200NE
100NE
0
180SW
270SW
360SW
450SW
1.0
2.0
4.0
6.0
8.0
131,000N
131,500N
131,000N
130,500N
130,000N
129,500N
129,000N
128,500N
128,000N
118,000E
118,500E
119,000E
119,500E
120,000E
120,500E
121,000E
inches
0
1
centimetres
0
1
2
BRITISH COLUMBIA GEOLOGICAL SURVEY
This reference scale bar has been added to the original image. It will scale at the same rate as the image, therefore it can be used as a reference for the original size.
400'
% FE CONTOUR
AREAS < 1.0% FE
DIAMOND DRILL HOLE
Phase 1 holes
Phase 2 holes
Phase 3 holes
KRAIN PROPERTY
MARCH, 1971